

AD-A105 153

HOSKINS-WESTERN-SONDEREGGER INC LINCOLN NE  
NATIONAL DAM SAFETY PROGRAM. DORAMUS LAKE DAM (MO 20139), MISSO--ETC(U)  
SEP 78 H P HOSKINS

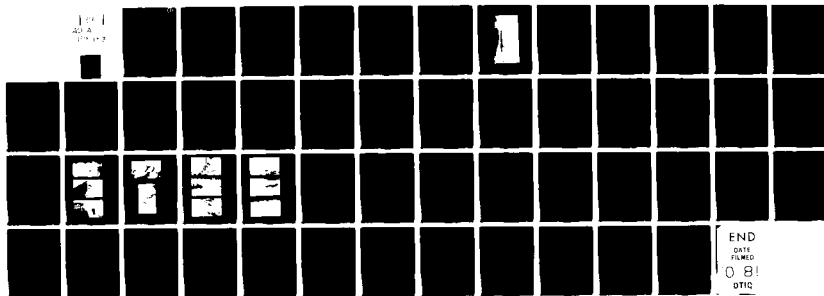
F/6 13/13

DACW43-78-C-0155

NL

UNCLASSIFIED

AD-A  
105 153



END  
DATE  
FILMED  
08  
DTIC

**MISSOURI**  
**MISSOURI-KANSAS CITY BASIN**



**AD A105153**

**LEVEL II**

**DORAMUS LAKE DAM**  
**JACKSON COUNTY, MISSOURI**  
**MO 20139**

**PHASE 1 INSPECTION REPORT**  
**NATIONAL DAM SAFETY PROGRAM**

**DTIC FILE COPY**



**DTIC**  
**ELECTED**  
**S** OCT 7 1981  
**D**

**PREPARED BY: HOSKINS-WESTERN-SONDEREGGER, INC.**  
**FOR: STATE OF MISSOURI**

**SEPTEMBER, 1978**

**DISTRIBUTION STATEMENT A**  
**Approved for public release;**  
**Distribution Unlimited**

**81 10 7 074**

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A105153	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Phase I Dam Inspection Report National Dam Safety Program Doramus Lake Dam (MO 20139) Jackson County, Missouri		5. TYPE OF REPORT & PERIOD COVERED Final Report
7. AUTHOR(s) Hoskins-Western-Sonderegger, Inc.  Harold P. /Hoskins		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101		8. CONTRACT OR GRANT NUMBER(s)  DACW43-78-C-0155
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS  11) 12) 13) 14)
14. MONITOR National Dam Safety Program. Doramus Lake Dam (MO 20139), Missouri - Kansas City Basin, Jackson County, Missouri. Phase I Inspection Report.		12. REPORT DATE September 1978
		13. NUMBER OF PAGES Approximately 45
		15. SECURITY CLASS. (of this report)  UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this report)  Approved for release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number)  Dam Safety, Lake, Dam Inspection, Private Dams		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.		

DD FORM 1 JAN 73 1473

EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)



SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)



DEPARTMENT OF THE ARMY  
ST. LOUIS DISTRICT, CORPS OF ENGINEERS  
210 NORTH 12TH STREET  
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Doramus Lake Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Doramus Lake Dam:

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

- 1) Spillway will not pass 50 percent of the Probable Maximum Flood.
- 2) Overtopping could result in dam failure.
- 3) Dam failure significantly increases the hazard to loss of life downstream

SUBMITTED BY:

SIGNED  
Chief, Engineering Division

2 APR 1979

Date

APPROVED BY:

Colonel, CE, District Engineer

4 APR 1979

Date

Accession For	
NTIS GRA&I	<input checked="" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A	

DTIC  
S  
OCT 7 1981

D

PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM  
DORAMUS LAKE DAM  
ID. NO. MO 20139

TABLE OF CONTENTS

<u>PARAGRAPH NO.</u>	<u>TITLE</u>	<u>PAGE NO.</u>
	Assessment Summary	AS-1
	Overview Photograph	OP-1
SECTION 1 - PROJECT INFORMATION		
1.1	General	1
1.2	Description of Project	1
1.3	Pertinent Data	2
SECTION 2 - ENGINEERING DATA		
2.1	Design	5
2.2	Construction	5
2.3	Operation	5
2.4	Evaluation	5
SECTION 3 - VISUAL INSPECTION		
3.1	Findings	6
3.2	Evaluation	8
SECTION 4 - OPERATIONAL PROCEDURES		
4.1	Procedures	9
4.2	Maintenance of Dam	9
4.3	Maintenance of Operating Facilities	9
4.4	Description of Any Warning System in Effect	9
4.5	Evaluation	9
SECTION 5 - HYDRAULIC/HYDROLOGIC		
5.1	Evaluation of Features	10
SECTION 6 - STRUCTURAL STABILITY		
6.1	Evaluation of Structural Stability	12
SECTION 7 - ASSESSMENT/REMEDIAL MEASURES		
7.1	Dam Assessment	13
7.2	Remedial Measures	13

<u>PLATE NO.</u>	<u>TITLE</u>
	<u>APPENDIX A-MAPS</u>
A-1	Vicinity Photography
A-2	Location Map
	<u>APPENDIX B-PHOTOGRAPHS</u>
B-1	Photos 2 through 4
B-2	Photos 5 and 6
B-3	Photos 7 through 9
B-4	Photos 10 through 12
	<u>APPENDIX C-PLAN, PROFILE AND SECTION</u>
C-1	Phase I-Plan, Profile and Section
	<u>APPENDIX D-HYDROLOGIC COMPUTATIONS</u>
D-1	Hydrologic Data
D-2	Inflow Hydrographs
D-3 and D-4	Weir Flow Rating Computations
D-5	Culvert Flow Rating Computations
D-6	Weir/Culvert Rating Curve
D-7 through D-11	Flow over Dam Embankment Computations
D-12 through D-14	Input Data (PMF, 0.5 PMF and 100 year)
D-15 and D-16	Reservoir Routing (PMF)
D-17	Reservoir Routing (0.5 PMF)
D-18	Reservoir Routing (100 year)



PHOTO NO. 1  
OVERVIEW  
LOOKING WEST TO DAM

OP-1



PHASE I REPORT  
NATIONAL DAM SAFETY PROGRAM

Name of Dam	Dorumus Lake Dam
State Located	Missouri
County Located	Jackson County
Stream	Tributary to Blue River
Date of Inspection	September 21, 1978

Dorumus Lake Dam was inspected by an interdisciplinary team of engineers from Hoskins-Western-Sonderegger, Inc. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers, and developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam is classified as a small size dam with a high downstream hazard potential. Failure would threaten life and property. The estimated damage zone extends 1.5 miles downstream of the dam. Within the damage zone are three to four houses, two unimproved roads and two improved roads. Also located downstream of the dam is a smaller lake.

Our inspection and evaluation indicates that in consideration of the small amount of water impounded, the large floodplain downstream and the maximum of four houses downstream, 50% of the Probable Maximum Flood is the appropriate design flood. The spillways of this dam do not meet this criteria. The spillways will pass the 100 year flood (flood having a one percent chance of being exceeded in any year) without overtopping. The spillways will pass 28% of the Probable Maximum Flood without overtopping the dam. The Probable Maximum Flood (PMF) is defined as the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These analyses should be obtained in the future.

Deficiencies visually observed by the inspection team were trees and bushes growing on both slopes of the dam, deterioration of the concrete weir in some locations, a wire fence on top of the concrete weir which could affect the operation of the principal spillway, inlet channel to secondary spillway overgrown with weeds, considerable erosion

of the principal spillway channel below the four CMP outlet pipes, exit channel from principal spillway overgrown with trees and brush, approximately 100 feet of secondary spillway channel overgrown with trees and brush, and seepage below the principal spillway outlet channel.

Several items of preventive maintenance need to be initiated by the owner. These are described in detail in the body of the report.

*H. P. Hoskins*

Harold P. Hoskins, P.E.  
Hoskins-Western-Sonderegger, Inc.  
Lincoln, Nebraska

PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM  
DORAMUS LAKE DAM - MO 20129  
JACKSON COUNTY, MISSOURI

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

- a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of Doramus Lake Dam be made.
- b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.
- c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed with the help of several Federal agencies and many State agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

- a. Description of Dam and Appurtenances.
  - (1) The dam is an earth fill originally constructed by the KC&S railroad to store water for use in steam locomotives. Topography adjacent to the site is gently rolling. Materials exposed in the surrounding slopes consist of loess or reworked loessial soils underlain by shales and limestones.
  - (2) The primary spillway is located on the left (south) end of the dam and consists of a weir with four 48-inch corrugated metal pipe (CMP) outlets.
  - (3) The secondary or emergency spillway is located on the right end of the dam and consists of four 24-inch CMP outlets.
  - (4) Pertinent physical data are given in Paragraph 1.3, below.
- b. Location. The dam is located in the southwestern corner of Jackson County, Missouri, as shown on Plate 2. The dam and the lake formed by the dam is shown on Plate 1 in the SE 1/4 of Section 15 and the NE 1/4 of Section 22, T13S, R33W.

- c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in Paragraph 1.1c above. Based on these criteria, this dam and impoundment is in the small size category.
- d. Hazard Classification. Guidelines for determining hazard classification are presented in the same guidelines as referenced in Paragraph c above. Based on referenced guidelines, this dam is in the High Hazard Classification. The estimated damage zone extends 1.5 miles downstream of the dam. Within the damage zone are three to four houses, two improved roads and two unimproved roads. Also, located just downstream from Doramus Lake Dam is a much smaller dam.
- e. Ownership. This dam is owned by Midwest Research Institute, 13100 Robinson Pike Road, Grandview, Missouri 64030.
- f. Purpose of Dam. The dam forms a 9 acre  $\pm$  recreational lake.
- g. Design and Construction History. No design or construction records were available on the dam. It was reported that the dam was constructed 75 to 100 years ago to store water for Kansas City and Southern Railroad locomotives. The four 24-inch culverts serving as an emergency spillway on the right abutment were installed in 1960 or 1961 when the adjacent road was constructed.
- h. Normal Operating Procedure. There are no controlled outlets for this dam. It was reported that the lake is spring fed and that the lake level is fairly stable. It was also reported that the spillways operate frequently but the dam has not been overtopped.

### 1.3 PERTINENT DATA

- a. Drainage area. 184 acres (0.29 square mile).
- b. Discharge at Damsite.
  - (1) All discharge at the damsite is over a primary spillway consisting of an uncontrolled drop-inlet type weir and set of culverts near the left abutment and through a secondary spillway consisting of a set of culverts near the right abutment.
  - (2) Estimated maximum flood at damsite - unknown.

- (3) The primary spillway weir capacity varies from 0 c.f.s. at crest elevation of 990.0 feet to 325 c.f.s. at elevation 992.9 feet (low point on dam crest). The set of four 48" CMP culverts become the predominant control over the weir at 993.6 feet, after the dam has overtopped.
- (4) The secondary spillway culvert (set of four 24" CMP) capacity varies from 0 c.f.s. at 990.0 feet to 75 c.f.s. at elevation 992.9 feet (low point on dam crest).
- (5) The maximum pool elevation is 992.9 feet (low point on dam crest).
- (6) The total spillway capacity at maximum pool level is 400 c.f.s.

c. Elevation (Feet Above M.S.L.).

- (1) Top of dam (low point) - 992.9.
- (2) Primary spillway weir crest - 990.0.  
Primary spillway culverts inlet invert - 984.5.
- (3) Secondary spillway culverts inlet invert - 990.0.
- (4) Streambed at center line of dam - 960 ±.
- (5) Maximum tailwater - unknown.

d. Reservoir. - Length of maximum pool - 1,500 feet ±.

e. Storage (Acre-feet).

- (1) Top of dam - 97.
- (2) Spillway crest - 70.

f. Reservoir Surface (Acres).

- (1) Top of dam - 10 ±.
- (2) Spillway crest - 9 ±.

g. Dam.

- (1) Type - Earth embankment.
- (2) Length - 450 feet ±.
- (3) Height - 33 feet ±.

- (4) Top width - 14 feet.
- (5) Side slopes.
  - (a) Downstream - 2.8H on 1V (measured).
  - (b) Upstream - 3H on 1V (measured on exposed section).
- (6) Zoning - unknown.
- (7) Impervious core - unknown.
- (8) Cutoff - unknown.
- (9) Grout curtain - unknown.
- (10) Wave protection - none.
- h. Diversion and Regulation. None
- i. Spillways.
  - (1) Primary.
    - (a) Type - Reinforced concrete broad-crested weir drop inlet with a set of four 48" CMP culverts.
    - (b) Length of weir (stepped) and crest elevation - 28 feet at 990.0 feet; plus 6 feet at 990.9 feet; plus 18 feet at 993.1 feet.
    - (c) Culvert invert elevation - 984.5 feet.
  - (2) Secondary.
    - (a) Type - Set of four 24" CMP culverts.
    - (b) Invert elevation - 990.0 feet.
- j. Regulating Outlets. None.

## SECTION 2 - ENGINEERING DATA

### 2.1 DESIGN

No design data were available for this dam.

### 2.2 CONSTRUCTION

No construction data were available for this dam. It was reported that the secondary spillway on the right abutment was installed in 1960 or 1961.

### 2.3 OPERATION

There are no controlled outlets for this structure. It was reported that the lake level remains fairly constant and that the spillways flow frequently.

### 2.4 EVALUATION

- a. Availability. There were no engineering data available for this dam.
- b. Seepage and Stability Analyses. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

### SECTION 3 - VISUAL INSPECTION

#### 3.1 FINDINGS

- a. General. A visual inspection of Doramus Lake Dam was made on September 21, 1978. Engineers from the firm of Hoskins-Western-Sonderregger, Inc., Lincoln, Nebraska making the inspection were: Stephen Nickel, Geology and Soil Mechanics; Gordon Jamison, Hydrology and Hydraulics; Garold Ulmer, Civil Engineer; and Richard Walker, Hydrology. Specific observations are discussed below.
- b. Dam. The upstream slope above the water line was found to be covered with grass. There was one tree near the center of the dam and several small trees or bushes in the vicinity of the primary spillway weir near the left abutment of the dam. There was an area of recently-placed gravel on the upstream slope between center line stations 3+25 and 3+60. This was reported to be an area where surplus gravel from another part of the property was wasted.

Portions of the downstream slope of the dam were covered with grass. At the highest section of the dam, the slope was covered by a dense growth of weeds and bushes. Several small trees were growing on the embankment near the left abutment. The density of the growth of weeds and bushes at the highest section of the embankment made it difficult to determine the condition of this section of the embankment. The remainder of the embankment appeared to be in good condition, with no slides or seepage being noted. The materials exposed on the slopes of the dam were mostly silty clay, with some gravel on parts of the upstream slope.

The abutments apparently consist of plastic silty clay, similar to that in the embankment, overlying limestone ledges alternating with beds of shale. A limestone outcrop was observed immediately upstream from the left abutment of the embankment. This area was reported to be a spring, but water was not flowing at the time of the inspection. However, the ground surface in the area was very wet. No slides were noted in the abutments. Seepage that was found is discussed under Paragraph e, below.

It was reported that there is a rock-filled infiltration pit below the downstream toe near the right abutment. This pit was constructed to receive chemical wastes and permit them to seep slowly into the soil. It is rarely used at the present, and when in use the pit is not under a pressure head. It should pose no threat to the dam.



c. Appurtenant Structures.

- (1) Primary Spillway. The primary spillway consists of a weir with four 48-inch CMP outlet pipes, built at the left end of the embankment. Spillway details are shown in Appendix C. The concrete in the weir appears to be serviceable, but the surface is deteriorating in some locations. A wire fence along the top of the weir could affect the operation of the spillway. The four outlet pipes appear to be in good condition.
- (2) Secondary Spillway. A secondary spillway, consisting of four 24-inch CMP culverts, passes through the embankment near the right abutment. The elevation of the inverts of these pipes is the same as the weir elevation. The inlet channel to the secondary spillway was overgrown with weeds. No other outlet works were found.

d. Reservoir Area. No wave wash, excessive erosion, or slides were observed along the shore of the reservoir.

e. Downstream Channel. The primary spillway exit channel is excavated out of the left abutment and descends that abutment at a slope of between 5 and 10%. There is considerable erosion in the channel immediately below the four CMP outlet pipes. If allowed to continue, this erosion could threaten the embankment. Limestone blocks are exposed in the eroded bottom of the exit channel. At the time of the inspection, the spillway flow (approximately 4 gallons per minute) was disappearing into voids in the limestone blocks approximately 40 to 50 feet downstream from the embankment. Seepage of the same relative magnitude was found to the right of and below the exit channel at this location. The seepage appeared to come from the exit channel rather than from the reservoir. The exit channel is relatively well defined to a point approximately 300 feet below the embankment, where the channel empties onto the left shore of the small reservoir below Doramus Lake Dam. For its entire length the exit channel is overgrown with trees and brush.

The secondary spillway exit channel is excavated out of the right abutment below the embankment and descends that abutment at a slope of between 5 and 10%. No erosion was noted in the channel. No limestone outcrops were seen. No water was flowing in the channel, and no seepage was observed. The secondary spillway exit channel is relatively well defined to a point approximately 200 feet downstream from the embankment, where the channel empties onto the right shore of the small reservoir below Doramus Lake Dam. The first 100 feet of this channel are overgrown with trees and brush. The remainder of the channel is grass.

The small reservoir downstream from Doramus Lake Dam is retained by a low dam having a single CMP outlet pipe approximately 30 inches in diameter. No emergency spillway was apparent. It was reported that this dam was overtopped in 1977. The outlet pipe appeared to be relatively new, and the embankment in the vicinity of the outlet pipe appeared to be recently constructed.

- f. Downstream Hazards. Downstream hazards are described in Section 5.

### 3.2 EVALUATION

The erosion of the primary spillway outlet channel could lead to the potential of failure if left uncorrected. Additional studies would be required to determine the actual source of seepage below the primary spillway outlet channel and to determine the effect of this seepage on the stability of the dam. The flat side slopes on this embankment would ordinarily provide adequate safety against shear failures for a dam of this height. The heavy vegetation on the downstream slope made it impossible to fully observe the structural conditions on the slope. The trees now growing on the upstream and downstream slopes, if allowed to continue to grow, would have the potential of causing failure of the dam by piping along their roots. The weir has a potential for failure if the concrete is allowed to deteriorate.

## SECTION 4 - OPERATIONAL PROCEDURES

### 4.1 PROCEDURES

There are no controlled outlet works for this dam and no regulating procedures exist.

### 4.2 MAINTENANCE OF DAM

Those portions of the embankment covered by grass appear to be regularly mowed. The size of the trees and brush in those areas not regularly mowed indicates that it has been several years since any vegetative control measures have been performed. The roadway on the crest of the dam has a relatively new bituminous surface.

### 4.3 MAINTENANCE AND OPERATING FACILITIES

No operating facilities exist at this dam.

### 4.4 DESCRIPTION OF WARNING SYSTEM IN EFFECT

The inspection team is not aware of any warning system at this dam.

### 4.5 EVALUATION

Trees and brush growing on the upstream and downstream slopes could lead to the potential of failure if not controlled.

## SECTION 5 - HYDRAULIC/HYDROLOGIC

### 5.1 EVALUATION OF FEATURES

- a. Design Data. No original or rehabilitation design data were found for this dam.
- b. Experience. The drainage area, lake surface area, and elevation-storage data were developed from the U.S.G.S. Grandview Missouri-Kansas 7 1/2 minute quadrangle topographic map. The hydraulic computations for the spillways and dam overtopping discharge ratings were developed from observations and data collected in the field at the time of the field inspection.
- c. Visual Observations.
  - (1) The left upstream corner of the R/C weir has been broken off for a width of about 1 foot and 1 foot in depth.
  - (2) The spillway appears to be used every time there is significant runoff.
  - (3) Spillway use should not endanger the dam.
- d. Overtopping Potential. The spillways are too small to pass the 1/2 probable maximum flood without overtopping. The spillways will pass the 0.28 PMF without overtopping (0.0 freeboard). The spillways will pass the 24-hour 100-year frequency flood without overtopping. The 100-year frequency (1%) flood outflow discharge is approximately 80 percent of the spillway capacity. The results of the routings through the reservoir are tabulated in regards to the following conditions.

<u>Frequency</u>	<u>Peak Inflow Discharge c.f.s.</u>	<u>Peak Outflow Discharge c.f.s.</u>	<u>Maximum Pool Elevation</u>	<u>Freeboard Top of Dam Min. Elev. 992.9</u>	<u>Time Dam Overtopping Hrs.</u>
100-Year	410	320	992.5	+0.4	-
1/2 PMF	910	880	993.6	-0.7	1.5
PMF	1830	1790	994.4	-1.5	5.3
0.28 PMF	500	400	992.9	0	-

According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, this dam is classified as having a high hazard rating and a small size. The Standard Design Flood for a small dam varies from one-half PMF to PMF. In consideration of the small volume of water impounded, the large flood plain downstream and the maximum of four houses downstream, one-half PMF is the appropriate spillway design flood.

The St. Louis District, Corps of Engineers, in a letter dated 11 August, 1978 has estimated the damage zone as extending 1.5 miles downstream from the dam. Within the damage zone are three to four houses, two unimproved roads, and two improved roads. Also located just downstream from the dam is a much smaller dam.

## SECTION 6 - STRUCTURAL STABILITY

### 6.1 EVALUATION OF STRUCTURAL STABILITY

- a. Visual Observations. Visual observations of features which could adversely affect the stability of the dam are discussed in Section 3. These include the following features: brush and trees on the upstream and downstream slopes, the fence along the crest of the weir, the erosion of the principal spillway outlet channel at the downstream toe, and the seepage below the outlet channel at the downstream toe.
- b. Design and Construction Data. No design or construction data were available.
- c. Operating Records. There are no operating structures at this dam.
- d. Post-Construction Changes. The auxiliary spillway was constructed when the road across the dam was paved in 1960 or 1961. The four 48-inch CMP in the primary spillway are obviously not 75 to 100 years old, as is the dam. It is not known when this modification was made.
- e. Seismic Stability. This dam is in Seismic Zone 1. An earthquake of the magnitude used for design in this zone is not expected to cause structural failure of this dam.

## SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

### 7.1 DAM ASSESSMENT

- a. Safety. Several items were noted during the visual inspection which could seriously threaten the safety of the dam if not controlled. These items include trees and brush on sections of the upstream and downstream slopes of the dam, erosion of the primary spillway outlet channel at the downstream toe of the dam, seepage below the primary spillway outlet channel, and the wire fence along the crest of the spillway weir. The Probable Maximum Flood will overtop the dam, as will the 1/2 PMF. The spillway will pass 28% of the PMF before the dam is overtopped. The dam will retain the 100-year flood without overtopping.
- b. Adequacy of Information. Since no engineering or construction data were available, the conclusions of this report are based upon performance history and visual observations. The inspection team considers that these data are sufficient to support the conclusions herein. Neither a seepage nor a stability analysis were found. This is a deficiency which should be corrected in the near future.
- c. Urgency. The remedial measures recommended in Paragraph 7.2, below, should be accomplished in the near future.
- d. Necessity for Phase II. A Phase II investigation is not called for. However, additional engineering data and analyses should be obtained by the owner to evaluate and design recommended remedial measures.
- e. Seismic Stability. The dam is located in Seismic Zone I. An earthquake of the magnitude used for design in this seismic zone is not expected to be hazardous to this dam.

### 7.2 REMEDIAL MEASURES

- a. Alternatives. The size of the spillway and/or the height of the dam should be increased and/or the permanent pool elevation should be lowered so that the Probable Maximum Flood can be passed without overtopping the dam. Regardless of which of these alternatives is chosen, additional investigations and analyses should be conducted to determine the structural characteristics and stability of the present embankment. These analyses should include a seepage analysis to determine the source of the seepage below the primary spillway exit channel near the downstream toe. The services of an engineer

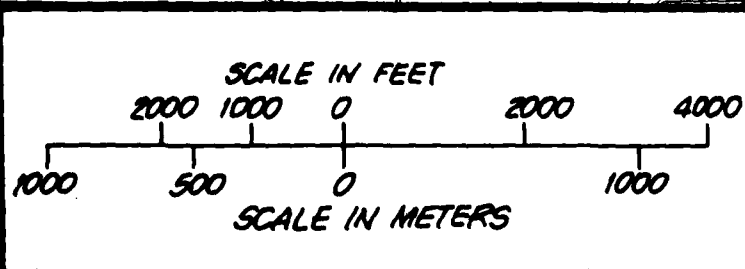
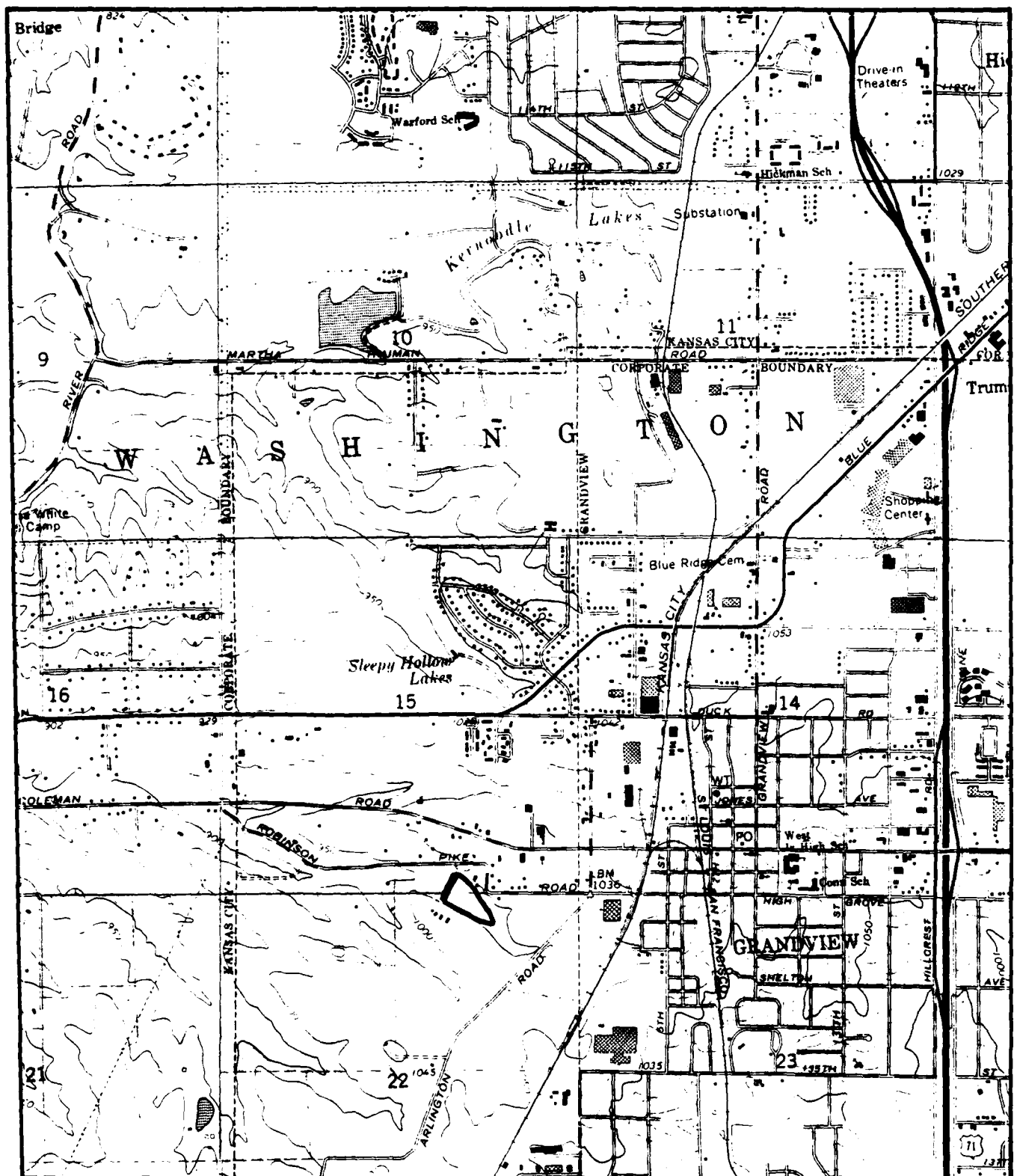
experienced in the design of dams should be obtained to perform the investigations and analyses of the present dam and to design the appropriate modifications and remedial measures.


b. O & M Maintenance and Procedures. The following O & M maintenance and procedures are recommended.

- (1) A program should be developed and put into action to remove trees and brush from the embankment and from the primary and auxiliary spillway exit channel and to permanently control vegetation in these areas to promote the growth of grass and prevent the regrowth of trees and brush.
- (2) The erosion in the primary spillway exit channel should be repaired and the spillway should be protected to prevent erosion.
- (3) The wire fence along the crest of the weir should be removed.
- (4) Deteriorated concrete in the weir should be removed and replaced.
- (5) The dam should be inspected regularly by qualified personnel to determine the presence of seepage on the downstream slope, in the abutments, below the downstream toe, or out of the exit channel, to determine the presence of slides in the downstream slope, to observe the upstream slope for any erosional damage, and to check for further deterioration of the concrete in the weir.

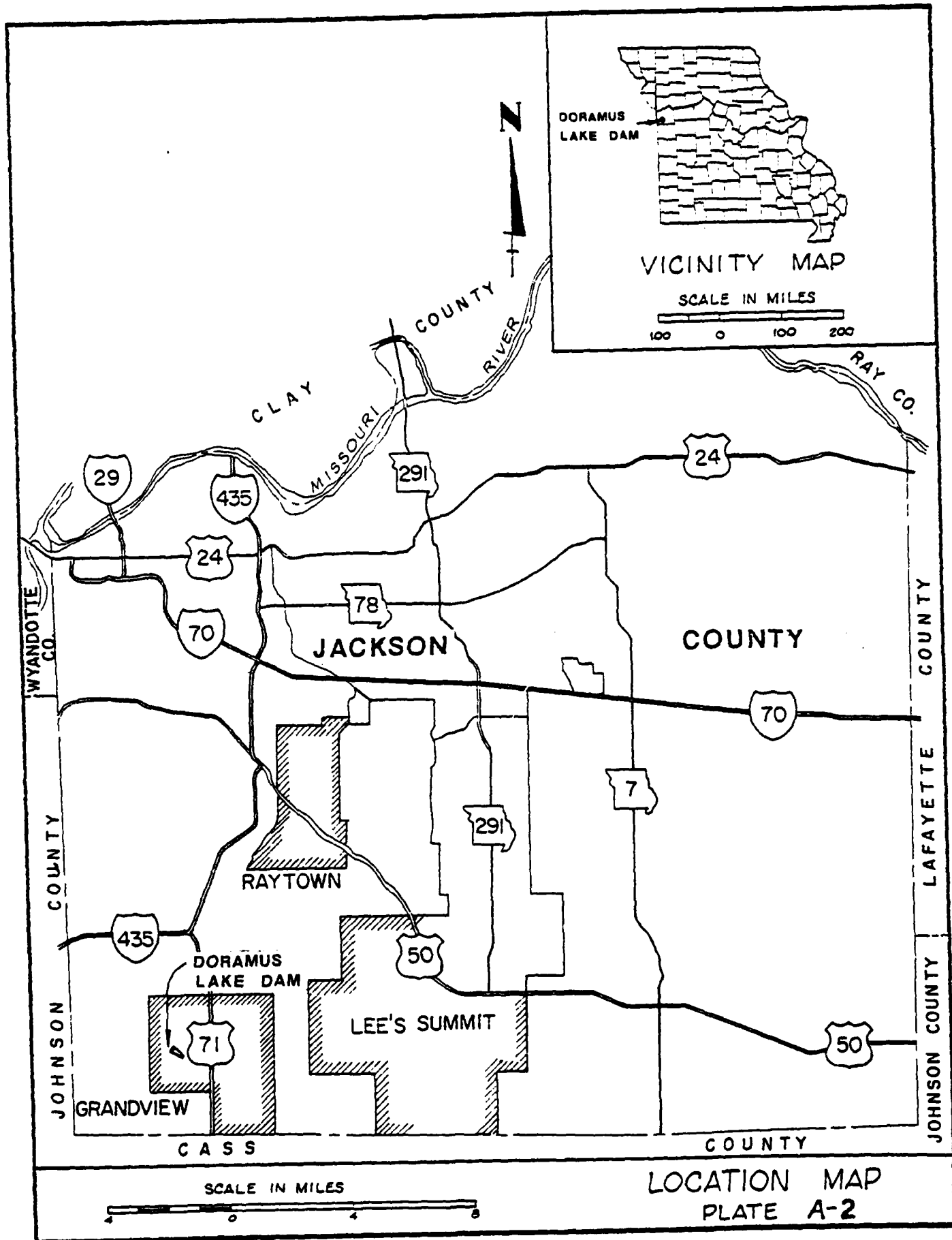


APPENDIX A  
MAPS





**DORAMUS  
LAKE DAM**  
 VICINITY TOPOGRAPHY  
 PLATE A-1



APPENDIX B  
PHOTOGRAPHS



PHOTO NO. 2  
UPSTREAM FACE  
FROM LEFT ABUTMENT



PHOTO NO. 3  
GRAVEL ON UPSTREAM  
FACE CENTER LINE  
STATION 3+25 TO 3+60



PHOTO NO. 4  
PRIMARY SPILLWAY WEIR

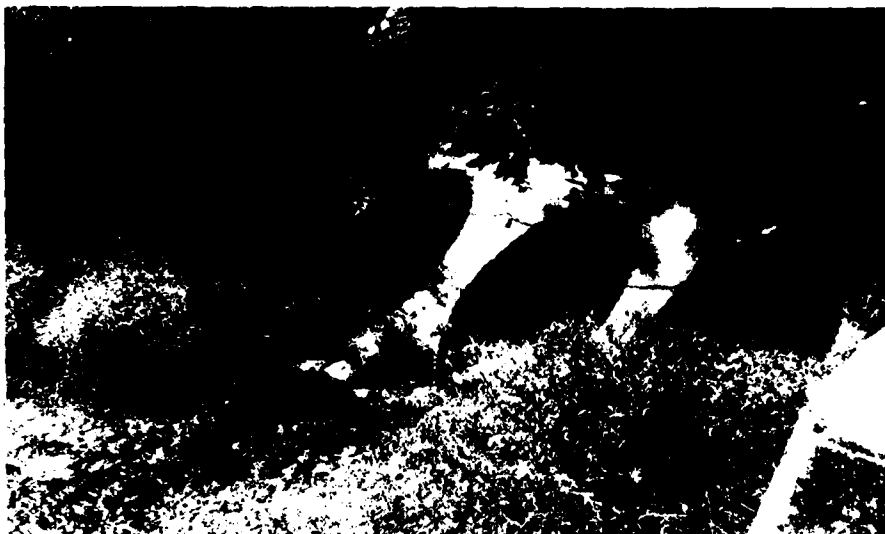


PHOTO NO. 5  
CMP OUTLET PIPES  
FOR PRIMARY SPILLWAY



PHOTO NO. 6  
EROSION IN PRIMARY  
SPILLWAY EXIT CHANNEL



PHOTO NO. 7  
AREA OF SEEPAGE  
RIGHT OF PRIMARY  
SPILLWAY EXIT CHANNEL



PHOTO NO. 8  
SECONDARY SPILLWAY  
INLET AT RIGHT  
ABUTMENT



PHOTO NO. 9  
SECONDARY SPILLWAY  
CMP INLETS

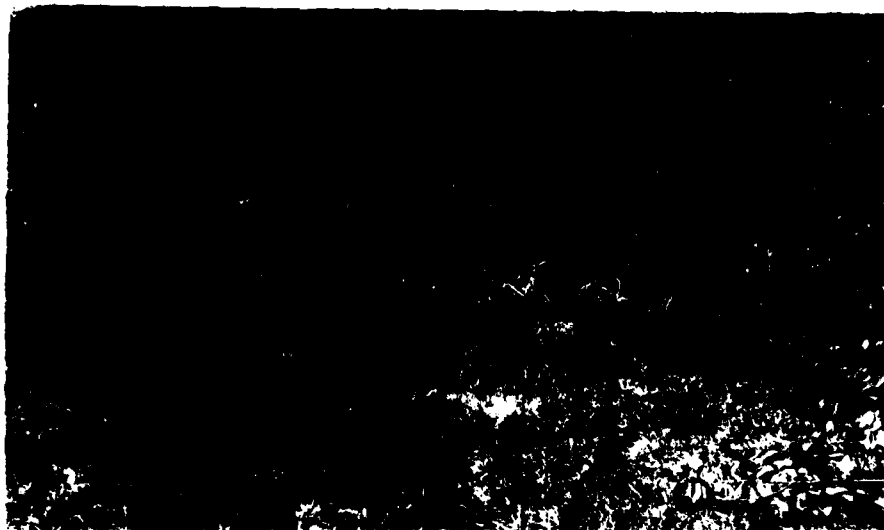


PHOTO NO. 10  
SECONDARY SPILLWAY  
EXIT CHANNEL



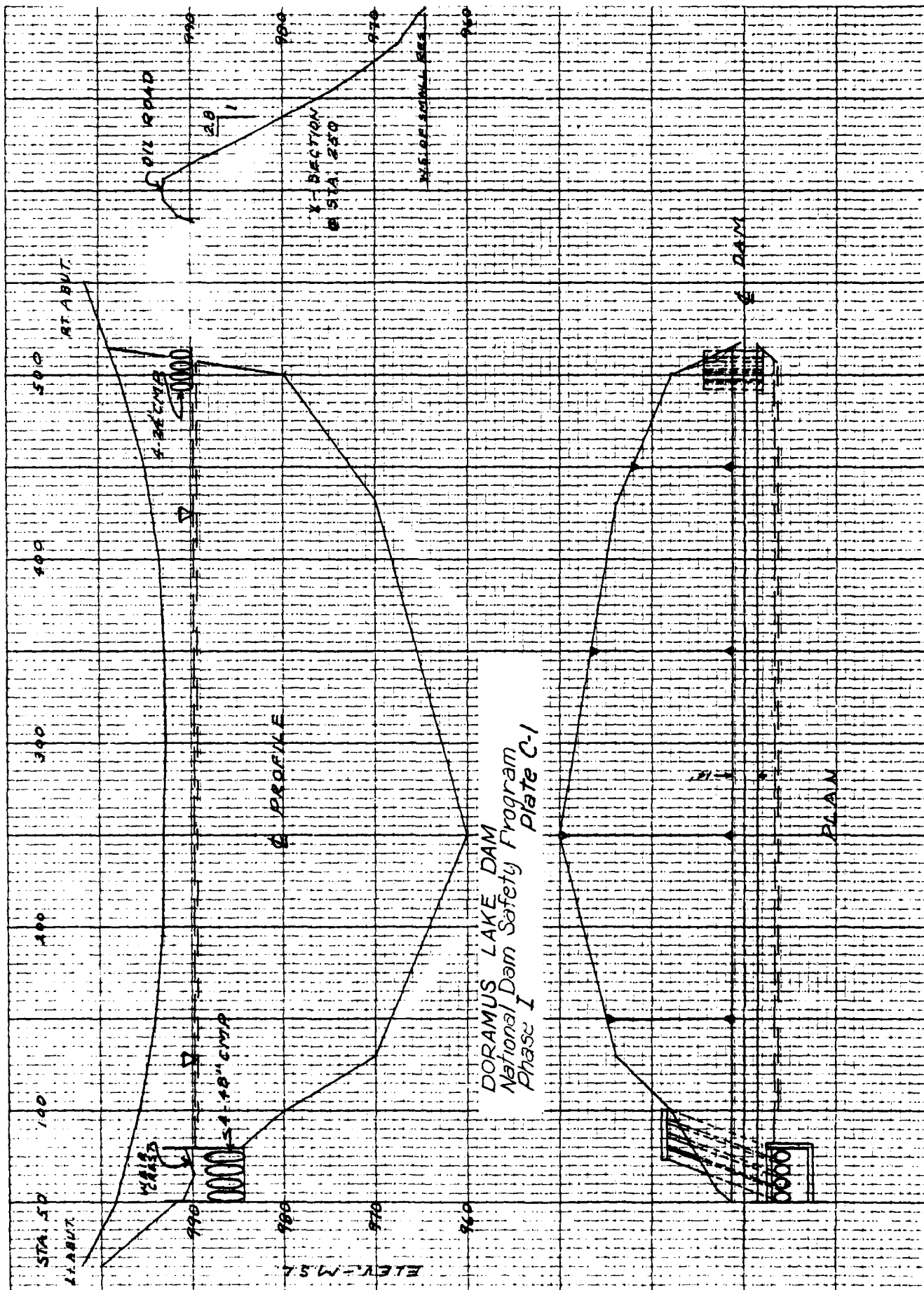
PHOTO NO. 11  
DOWNSTREAM FACE  
FROM BELOW RIGHT  
ABUTMENT



PHOTO NO. 12  
LOOKING DOWNSTREAM  
FROM CREST OF DAM  
TO SMALLER DAM BELOW



APPENDIX C  
PLAN, PROFILES & SECTION

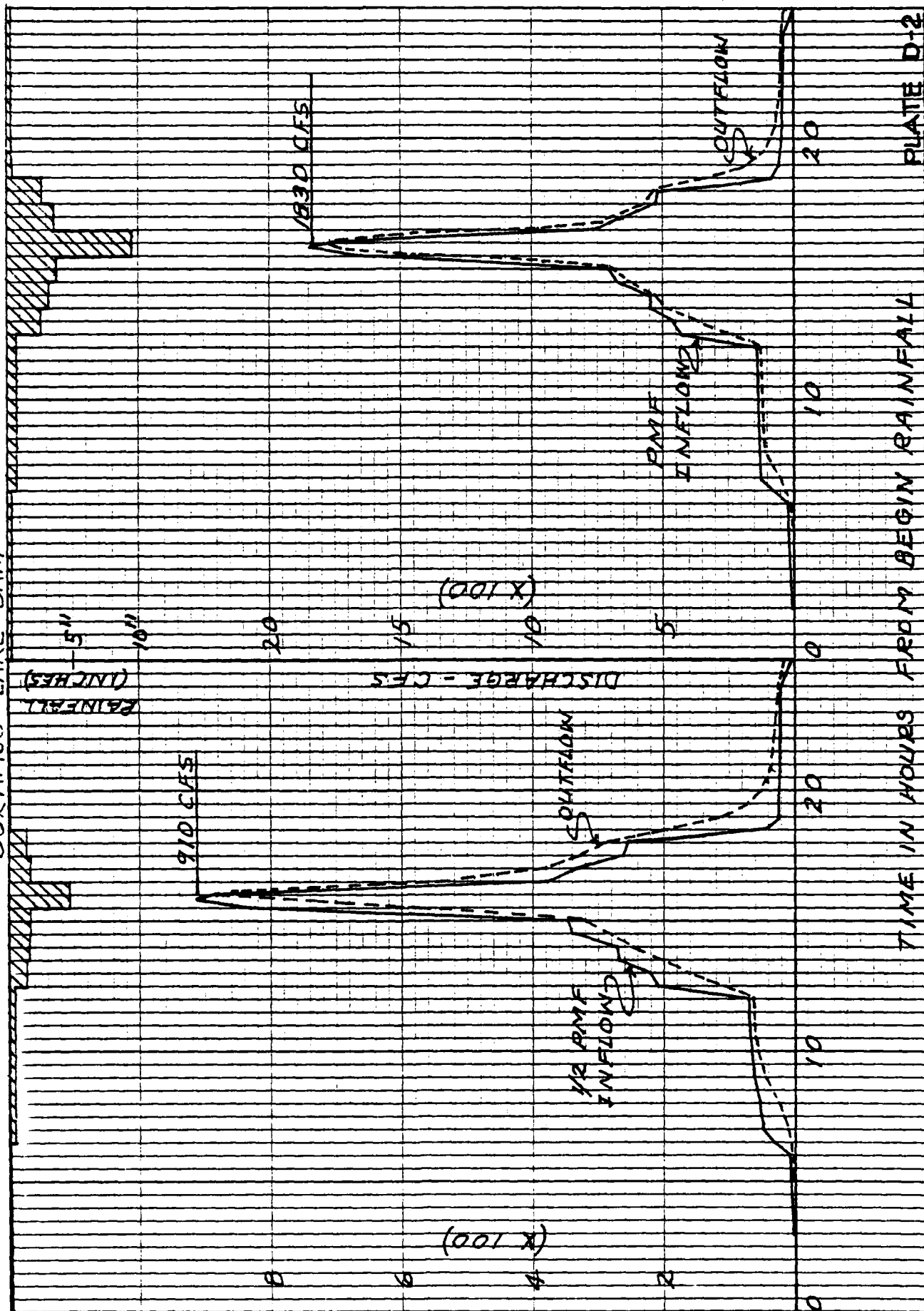


APPENDIX D  
HYDROLOGIC COMPUTATIONS

## HYDROLOGIC COMPUTATIONS

1. The Mockes dimensionless standard curvilinear unit hydrograph and the SCS TR-20 program were used to develop the inflow hydrographs (see Plate D1). The inflow hydrograph for the 100-year flood was generated by the consultant using the TR-20 program.
  - a. Six-hour, twelve-hour, and twenty-four hour 100-year rainfall for the dam location was taken from NOAA Technical Paper 40. The 24-hour probable maximum precipitation was taken from the curves of Hydrometeorological Report No. 33 and current Corps of Engineers and St. Louis District policy and guidance for hydraulics and hydrology.
  - b. Drainage area = 0.287 square mile (184 acres).
  - c. Time of concentration of runoff = 21 minutes.
  - d. The antecedent storm conditions were heavy rainfall and low temperatures which occurred on the previous 5 days (SCS AMCIII). The initial pool elevation was assumed at the crest of the primary spillway.
  - e. The total 24-hour storm duration losses for the 100-year storm were 0.87 inch. The total losses for the 24-hour duration 1/2 PMF storm were 0.91 inch. The total losses for the PMF storm were 0.95 inch. These data are based on SCS runoff curve No. 93 and antecedent moisture conditions from SCS AMCIII.
  - f. Average soil loss rates = 0.05 inch per hour approximately.
2. The weir/culvert discharge ratings were developed using standard formulas. The flows over the dam crest were based on the broad-crested weir equation  $Q = CLH^{3/2}$ , where H is the head on the dam crest; the coefficient C, which varies with head, was taken from the USGS publication "TWRI, Book 3, Chapter 5, Measurement of Peak Discharge at Dams by Indirect Methods".
3. Floods were routed through the reservoir using the TR-20 program to determine the capabilities of the spillways and dam embankment crest. The storm rainfall patterns, inflow hydrographs and routed outflow hydrographs are shown on Plate D2.

# DORAMUS LAKE DAM



## CALCULATIONS FOR

**PROJECT**

DORAMUS DAM

(No Name 8J-20139

## Weir Flow Rating

993.1

十

**2.7**

28

450.5



21-950-1

Vert. u.s. face

B = 62

५ २ १

PLATE D-3

HOSKINS-WESTERN-SONDEREGGER

COMPUTED BY GGJ DATE 12/16/78 SHEET NO. 78/3095 OF 10

CHECKED BY \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

CALCULATIONS FOR

PROJECT in Dam Insp.DORAMUS DAM(No Name 85) 20139Weir Flow Rating

$Q = C L H^{3/2}$ $L = 28'$ $H = 2.5'$ $B = 62'$ $P = 1'$									
Sta	Dist	Flow elev	Top of weir	Depth	Min depth	$H/C$	$C$	$C'$	$Q$
Lt E		993.1	990.6	2.5					
	14				2.8	1.12	3.05	2.44	16.0
Q	14		990.0	3.1	2.9	1.16	3.08	2.46	17.0
Rt E			990.4	2.7					
Lt. Curb			990.9	2.2					
	6				2.2	.88	2.90	2.38	4.7
Rt. Curb		993.1	990.9	2.2					
									37.7
$5/8 = .625$									
Lt. E		993.5	990.6	2.9					
	14				3.2	1.28	3.16	2.84	20.7
Q	14		990.0	3.5	3.3	1.32	3.13	2.86	24.0
Rt. E			990.4	3.1					
Lt. Curb			990.9	2.6					
	6				2.6	1.04	3.00	2.73	6.9
Rt. Curb			990.9	2.6					
Lt. HW			993.1	.4					
	18				.4	.16	2.63	2.55	1.2
Rt. HW		993.5	993.1	.4					
									52.8
Lt. E		994.0	990.6	3.4					
	14				3.7	1.48	3.28	2.95	29.4
Q	14		990.0	4.0	3.8	1.52	3.30	2.97	30.8
Rt. E			990.4	3.6					
Lt. Curb			990.9	3.1					
	6				3.1	1.24	3.14	2.83	9.3
Rt. Curb			990.9	3.1					
Lt. HW			993.1	.9					
	18				.9	.36	2.65	2.41	3.7
Rt. HW		994.0	993.1	.9					
									73.2

PLATE D-4

CALCULATIONS FOR

PROJECT

DORAMUS DAM  
(No Name 85) #20139Culvert Flow RatingUse nomograph Fig. 4-18, pg. 166, Hyd. of Culverts  
"Handbook of Steel Drainage & Highway Constr. Products"Culverts at Left end of Dam below Weir  
Mitered  
4-48" CMPs Assume Inlet control

$$PZF = 984.5$$

Elev	HW	HW/D(4')	Q	x 4 = Total Q
990.0	5.5	1.38	95	380
990.6	6.1	1.52	104	416
990.9	6.4	1.6	110	440
991.4	6.9	1.72	112	448
991.9	7.4	1.85	120	480
993.1	8.6	2.15	135	540
993.5	9.0	2.25	140	560
994.0	9.5	2.38	145	580
994.5	10.0	2.5	150	600

4 - 24" Culverts @ Rt. end dam

Headwall Flush

$$PZF = 990.0$$

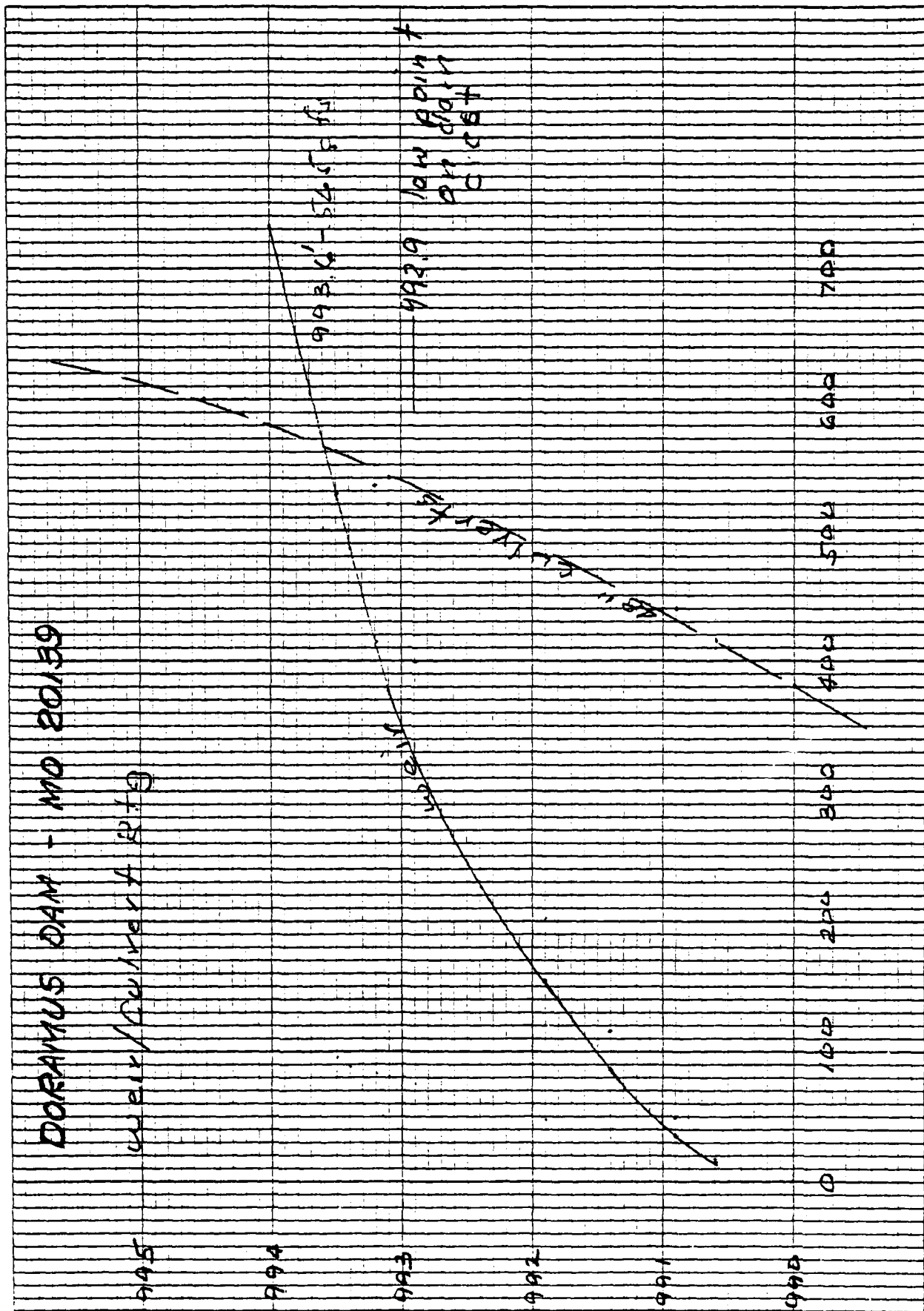
D=2

Elev	HW	HW/D(2')	Q	x 4 = Total Q
990.0	—	—	—	0
990.6	.6	.3	1.0	4.0
990.9	.9	.45	3.5	14
991.4	1.4	.7	7.5	30
991.9	1.9	.95	12	48
993.1	3.1	1.55	20	80
993.5	3.5	1.75	24	96
994.0	4.0	2.0	26	104
994.5	4.5	2.55	30	120



DORAMUS DAM - MO 20139

Weir/Culvert Rtg



Elevation

PLATE D-6

Discharge

### CALCULATIONS FOR

CHECKED BY \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER 78/3005

PROJECT No Down Ins.

Flow over Dam Embankment <sup>DORAMUS DAM</sup> (No Name 85) = 20130

See TWRI, Bk 3, Chap. 4-5 2:64

Sta	Dist b	Pool Elev.	Top of Dam Elev.	Depth h	Mn h	Mx $T=14$	C	Q
				Paved Top				
1+00			995.9					
1+50			994.0					
2+00		993.2	993.2	0				
2+50	.50	993.2	993.1	1	.25	6.15	290	3
3+00	.50	993.2	992.9	3	.20		297	13
3+50	.50	993.2	993.0	2	.25		298	12
<del>3+70</del> 4+00	20	993.2	993.5 <sup>2</sup>	0	.10		293	2
4+50			995.0					
5+00			997.8					
								36

PLATE D-7

OSKINS-WESTERN-SONDEREGGER

CALCULATIONS FOR

COMPUTED BY SGJ DATE 10/13/78 SHEET NO. 2 OF 78/3095  
 CHECKED BY \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

PROJECT Mo Dam Insp.

Flow over Dam Embankment (No Name 85) = 20139  
See TWRI, Bk 3, Chap. A-5 D=16H<sup>2/3</sup>

Sta.	Dist. b	Pool Elev.	Top of Dam Emb.	Depth h	Mn h	M <sub>2</sub> 2/14	C	Q
1+00			995.9					
1+50	23	993.5	994.0	0	.15	4.15	2.95	4
2+00	50	1	993.2	3	.35		3.00	3.1
2+50	50	1	993.1	4	.50		3.02	5.3
3+00	50	1	992.9	6	.55		3.02	6.2
3+50	50	1	993.0	5	.25		2.98	1.9
4+00		993.5	993.5	0				
4+50			995.0					
5+00			997.8					
								169

PLATE D-8

**DORAMUS DAM**

Flow over Dam Embankment (No Name 85) = 20139  
See TWEI, BK 3, Chap. A-5 D=0.64<sup>92</sup>

Sta.	Dist. b	Pool Elev.	Top of Dam Elev.	Depth h	M <sub>1</sub> h	M <sub>2</sub> Z=14	C	Q
1+00			995.9					
1+50		994.0	994.0	0				
2+00	50		993.2	.8	.4	<.5	3.00	33
2+50	50		993.1	.9	.85		3.03	119
3+00	50		992.9	1.1	1.0		3.04	152
3+50	50		993.0	1.0	1.05		3.04	164
4+00	50		993.5	.5	.75		3.03	114
4+50	16	994.0	993.0	0	.25		2.98	6
5+00			992.8					
							59.3	

KINKINS-WESTERN-SONDEREGGER

CALCULATIONS FOR

COMPUTED BY GGJ DATE 10/13/78 SHEET NO. 78 OF 3095

CHECKED BY \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

PROJECT MO DAM IMP.

Flow over Dam Embankment (No Name 85) = 20139

See TWRI, BK 3, Chap A-5  $Q = 0.64 \text{ } ^{92}$ 

Sta.	Dist. b	Pool Elev.	Top of Dam Emb.	Depth h	M <sub>1</sub> b	M <sub>2</sub> 2/14	C	Q
1+00		994.5	993.5	0				
1+35	15				2.5	1.5	219.3	16
1+50			994.0	.5				
	50				.9		30.3	29
2+00			993.2	1.3				
	50				1.35		30.4	238
2+50			993.1	1.2				
	50				1.5		30.4	279
3+00			992.9	1.6				
	50				1.55		30.4	293
3+50			993.0	1.5				
	50				1.25		30.4	212
4+00			993.5	1.0				
4+35	35	994.5	993.5	0	.5		30.2	37
5+00			992.8					
								1194

PLATE D-10

HOSKINS-WESTERN-SONDEREGGER

CALCULATIONS FOR

COMPUTED BY GGJ DATE 10/16/78 SHEET NO. 78/3095

CHECKED BY \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

PROJECT No Dam Insp.DORAMUS DAM  
(No Name 85) - # 20139

Total Flow

Elev.	Weir	48' Culv.	24" Culv.	Embank.	Total
994.0	0	—	0	—	0
990.6	15	↑	4		19
990.9	36	↑	14		50
991.4	86	↑	30		116
991.9	154	↑	48		202
dam 992.9	325	↑	75	0	400
993.2	415	↑	84	36	535
993.5	528	550	96	169	793
994.0	732	580	104	593	1277
( 994.5		600	120	1194	1914

HYDROLOGY PROGRAM FOR IBM 1130 - DATED JULY, 1968  
 NO DAM INSP-NO NAME AS) DORAMUS DAM  
 EXECUTIVE CONTROL CARD  
 OPERATION LIST

TR-20 ROUTING.

NO DAM INSP-NO NAME AS

C TABLE VELOCITY INCREMENT = 0.200

0	0.0000	0.0000	0.1000	0.2500	0.3200
0	0.0400	0.0400	0.4500	0.4900	0.5100
0	0.0800	0.0800	0.5000	0.6100	0.6300
0	0.1200	0.1200	0.6500	0.6900	0.7000
0	0.1600	0.1600	0.7000	0.7400	0.7500
0	0.2000	0.2000	0.7500	0.7900	0.8000
0	0.2400	0.2400	0.8000	0.8400	0.8500
0	0.2800	0.2800	0.8500	0.8900	0.9000
0	0.3200	0.3200	0.9000	0.9400	0.9500
0	0.3600	0.3600	0.9500	0.9900	1.0000
0	0.4000	0.4000	1.0000	1.0400	1.0500
0	0.4400	0.4400	1.0500	1.0900	1.1000
0	0.4800	0.4800	1.1000	1.1400	1.1500
0	0.5200	0.5200	1.1500	1.1900	1.2000
0	0.5600	0.5600	1.2000	1.2400	1.2500
0	0.6000	0.6000	1.2500	1.2900	1.3000
0	0.6400	0.6400	1.3000	1.3400	1.3500
0	0.6800	0.6800	1.3500	1.3900	1.4000
0	0.7200	0.7200	1.4000	1.4400	1.4500
0	0.7600	0.7600	1.4500	1.4900	1.5000
0	0.8000	0.8000	1.5000	1.5400	1.5500
0	0.8400	0.8400	1.5500	1.5900	1.6000
0	0.8800	0.8800	1.6000	1.6400	1.6500
0	0.9200	0.9200	1.6500	1.6900	1.7000
0	0.9600	0.9600	1.7000	1.7400	1.7500
0	1.0000	1.0000	1.7500	1.7900	1.8000
0	1.0400	1.0400	1.8000	1.8400	1.8500
0	1.0800	1.0800	1.8500	1.8900	1.9000
0	1.1200	1.1200	1.9000	1.9400	1.9500
0	1.1600	1.1600	1.9500	1.9900	2.0000
0	1.2000	1.2000	2.0000	2.0400	2.0500
0	1.2400	1.2400	2.0500	2.0900	2.1000
0	1.2800	1.2800	2.1000	2.1400	2.1500
0	1.3200	1.3200	2.1500	2.1900	2.2000
0	1.3600	1.3600	2.2000	2.2400	2.2500
0	1.4000	1.4000	2.2500	2.2900	2.3000
0	1.4400	1.4400	2.3000	2.3400	2.3500
0	1.4800	1.4800	2.3500	2.3900	2.4000
0	1.5200	1.5200	2.4000	2.4400	2.4500
0	1.5600	1.5600	2.4500	2.4900	2.5000
0	1.6000	1.6000	2.5000	2.5400	2.5500
0	1.6400	1.6400	2.5500	2.5900	2.6000
0	1.6800	1.6800	2.6000	2.6400	2.6500
0	1.7200	1.7200	2.6500	2.6900	2.7000
0	1.7600	1.7600	2.7000	2.7400	2.7500
0	1.8000	1.8000	2.7500	2.7900	2.8000
0	1.8400	1.8400	2.8000	2.8400	2.8500
0	1.8800	1.8800	2.8500	2.8900	2.9000
0	1.9200	1.9200	2.9000	2.9400	2.9500
0	1.9600	1.9600	2.9500	2.9900	3.0000
0	2.0000	2.0000	3.0000	3.0400	3.0500
0	2.0400	2.0400	3.0500	3.0900	3.1000
0	2.0800	2.0800	3.1000	3.1400	3.1500
0	2.1200	2.1200	3.1500	3.1900	3.2000
0	2.1600	2.1600	3.2000	3.2400	3.2500
0	2.2000	2.2000	3.2500	3.2900	3.3000
0	2.2400	2.2400	3.3000	3.3400	3.3500
0	2.2800	2.2800	3.3500	3.3900	3.4000
0	2.3200	2.3200	3.4000	3.4400	3.4500
0	2.3600	2.3600	3.4500	3.4900	3.5000
0	2.4000	2.4000	3.5000	3.5400	3.5500
0	2.4400	2.4400	3.5500	3.5900	3.6000
0	2.4800	2.4800	3.6000	3.6400	3.6500
0	2.5200	2.5200	3.6500	3.6900	3.7000
0	2.5600	2.5600	3.7000	3.7400	3.7500
0	2.6000	2.6000	3.7500	3.7900	3.8000
0	2.6400	2.6400	3.8000	3.8400	3.8500
0	2.6800	2.6800	3.8500	3.8900	3.9000
0	2.7200	2.7200	3.9000	3.9400	3.9500
0	2.7600	2.7600	3.9500	3.9900	4.0000
0	2.8000	2.8000	4.0000	4.0400	4.0500
0	2.8400	2.8400	4.0500	4.0900	4.1000
0	2.8800	2.8800	4.1000	4.1400	4.1500
0	2.9200	2.9200	4.1500	4.1900	4.2000
0	2.9600	2.9600	4.2000	4.2400	4.2500
0	3.0000	3.0000	4.2500	4.2900	4.3000
0	3.0400	3.0400	4.3000	4.3400	4.3500
0	3.0800	3.0800	4.3500	4.3900	4.4000
0	3.1200	3.1200	4.4000	4.4400	4.4500
0	3.1600	3.1600	4.4500	4.4900	4.5000
0	3.2000	3.2000	4.5000	4.5400	4.5500
0	3.2400	3.2400	4.5500	4.5900	4.6000
0	3.2800	3.2800	4.6000	4.6400	4.6500
0	3.3200	3.3200	4.6500	4.6900	4.7000
0	3.3600	3.3600	4.7000	4.7400	4.7500
0	3.4000	3.4000	4.7500	4.7900	4.8000
0	3.4400	3.4400	4.8000	4.8400	4.8500
0	3.4800	3.4800	4.8500	4.8900	4.9000
0	3.5200	3.5200	4.9000	4.9400	4.9500
0	3.5600	3.5600	4.9500	4.9900	5.0000
0	3.6000	3.6000	5.0000	5.0400	5.0500
0	3.6400	3.6400	5.0500	5.0900	5.1000
0	3.6800	3.6800	5.1000	5.1400	5.1500
0	3.7200	3.7200	5.1500	5.1900	5.2000
0	3.7600	3.7600	5.2000	5.2400	5.2500
0	3.8000	3.8000	5.2500	5.2900	5.3000
0	3.8400	3.8400	5.3000	5.3400	5.3500
0	3.8800	3.8800	5.3500	5.3900	5.4000
0	3.9200	3.9200	5.4000	5.4400	5.4500
0	3.9600	3.9600	5.4500	5.4900	5.5000
0	4.0000	4.0000	5.5000	5.5400	5.5500
0	4.0400	4.0400	5.5500	5.5900	5.6000
0	4.0800	4.0800	5.6000	5.6400	5.6500
0	4.1200	4.1200	5.6500	5.6900	5.7000
0	4.1600	4.1600	5.7000	5.7400	5.7500
0	4.2000	4.2000	5.7500	5.7900	5.8000
0	4.2400	4.2400	5.8000	5.8400	5.8500
0	4.2800	4.2800	5.8500	5.8900	5.9000
0	4.3200	4.3200	5.9000	5.9400	5.9500
0	4.3600	4.3600	5.9500	5.9900	6.0000
0	4.4000	4.4000	6.0000	6.0400	6.0500
0	4.4400	4.4400	6.0500	6.0900	6.1000
0	4.4800	4.4800	6.1000	6.1400	6.1500
0	4.5200	4.5200	6.1500	6.1900	6.2000
0	4.5600	4.5600	6.2000	6.2400	6.2500
0	4.6000	4.6000	6.2500	6.2900	6.3000
0	4.6400	4.6400	6.3000	6.3400	6.3500
0	4.6800	4.6800	6.3500	6.3900	6.4000
0	4.7200	4.7200	6.4000	6.4400	6.4500
0	4.7600	4.7600	6.4500	6.4900	6.5000
0	4.8000	4.8000	6.5000	6.5400	6.5500
0	4.8400	4.8400	6.5500	6.5900	6.6000
0	4.8800	4.8800	6.6000	6.6400	6.6500
0	4.9200	4.9200	6.6500	6.6900	6.7000
0	4.9600	4.9600	6.7000	6.7400	6.7500
0	5.0000	5.0000	6.7500	6.7900	6.8000
0	5.0400	5.0400	6.8000	6.8400	6.8500
0	5.0800	5.0800	6.8500	6.8900	6.9000
0	5.1200	5.1200	6.9000	6.9400	6.9500
0	5.1600	5.1600	6.9500	6.9900	7.0000
0	5.2000	5.2000	7.0000	7.0400	7.0500
0	5.2400	5.2400	7.0500	7.0900	7.1000
0	5.2800	5.2800	7.1000	7.1400	7.1500
0	5.3200	5.3200	7.1500	7.1900	7.2000
0	5.3600	5.3600	7.2000	7.2400	7.2500
0	5.4000	5.4000	7.2500	7.2900	7.3000
0	5.4400	5.4400	7.3000	7.3400	7.3500
0	5.4800	5.4800	7.3500	7.3900	7.4000
0	5.5200	5.5200	7.4000	7.4400	7.4500
0	5.5600	5.5600	7.4500	7.4900	7.5000
0	5.6000	5.6000	7.5000	7.5400	7.5500
0	5.6400	5.6400	7.5500	7.5900	7.6000
0	5.6800	5.6800	7.6000	7.6400	7.6500
0	5.7200	5.7200	7.6500	7.6900	7.7000
0	5.7600	5.7600	7.7000	7.7400	7.7500
0	5.8000	5.8000	7.7500	7.7900	7.8000
0	5.8400	5.8400	7.8000	7.8400	7.8500
0	5.8800	5.8800	7.8500	7.8900	7.9000
0	5.9200	5.9200	7.9000	7.9400	7.9500
0	5.9600	5.9600	7.9500	7.9900	8.0000
0	6.0000	6.0000	8.0000	8.0400	8.0500
0	6.0400	6.0400	8.0500	8.0900	8.1000
0	6.0800	6.0800	8.1000	8.1400	8.1500
0	6.1200	6.1200	8.1500	8.1900	8.2000
0	6.1600	6.1600	8.2000	8.2400	8.2500
0	6.2000	6.2000	8.2500	8.2900	8.3000
0	6.2400	6.2400	8.3000	8.3400	8.3500
0	6.2800	6.2800	8.3500	8.3900	8.4000
0	6.3200	6.3200	8.4000	8.4400	8.4500
0	6.3600	6.3600	8.4500	8.4900	8.5000
0	6.4000	6.4000	8.5000	8.5400	8.5500
0	6.4400	6.4400	8.5500	8.5900	8.6000
0	6.4800	6.4800	8.6000	8.6400	8.6500
0	6.5200	6.5200	8.6500	8.6900	8.7000
0	6.5600	6.5600	8.7000	8.7400	8.7500
0	6.6000	6.6000	8.7500	8.7900	8.8000
0	6.6400	6.6400	8.8000	8.8400	8.8500
0	6.6800	6.6800	8.8500	8.8900	8.9000
0	6.7200	6.7200	8.9000	8.9400	8.9500
0	6.7600	6.7600	8.9500	8.9900	9.0000
0	6.8000	6.8000	9.0000	9.0400	9.0500
0	6.8400	6.8400	9.0500	9.0900	9.1000
0	6.8800	6.8800	9.1000	9.1400	9.1500
0	6.9200	6.9200	9.1500	9.1900	9.2000
0	6.9600	6.9600	9.2000	9.2400	9.2500
0	7.0000	7.0000	9.2500	9.2900	9.3000
0	7.0400	7.0400	9.3000	9.3400	9.3500
0	7.0800	7.0800	9.3500	9.3900	9.4000
0	7.1200	7.1200	9.4000	9.4400	9.4500
0	7.1600	7.1600	9.4500	9.4900	9.5000
0	7.2000	7.2000	9.5000	9.5400	9.5500</

0.6600  
1.6700  
3.6200  
5.6000  
13.0700  
26.1200  
31.2400  
31.6000  
32.2400

0.5900  
1.2400  
1.2300  
5.2000  
12.1700  
26.1500  
31.1300  
31.6700  
32.2400

0.5100  
0.0900  
2.0400  
4.8100  
9.6300  
24.5800  
31.0100  
31.5800  
32.1300

0.4400  
0.8100  
2.4500  
4.4100  
8.1300  
19.7700  
30.9000  
31.4700  
32.0200

0.3600  
0.7400  
2.0600  
4.0200  
8.0600  
16.9700  
29.5100  
31.3600  
31.9100

9 ENDIRL

RAINFALL TABLE NO. 4 TIME INCREMENT = 0.50

0.1200  
0.2700  
0.5400  
0.9900  
1.4600  
3.1300  
6.5300  
7.2900  
7.7000

0.0900  
0.2400  
0.4500  
0.9000  
1.3600  
2.7100  
6.1300  
7.2500  
7.4700

0.0600  
0.2100  
0.4600  
0.9100  
1.2700  
2.5700  
5.7300  
7.2000  
7.4500

0.0300  
0.1800  
0.3200  
0.3200  
1.1700  
2.0300  
7.0700  
7.3800  
7.6100

0.0000  
0.1300  
0.3000  
0.6300  
1.0800  
1.7400  
3.5600  
6.8400  
7.5600

9 ENDIRL



7 SUPPLY

# END OF LISTING

ADDITIONS TO TABULAR DATA FOLLOW

STRUCTURE NO. 1

990.0001 0.0000  
990.0000 19.0000  
990.0000 50.0000  
991.0000 116.0000  
991.0000 202.0000  
992.0000 400.0000  
993.0000 535.0001  
993.0001 793.0001  
994.0001 1277.0002  
994.5001 1914.0002

EXECUTIVE CONTROL CARD  
EXECUTIVE CONTROL CARD  
STARTING TIME= 0.00  
ALTERNATE NO.= 1

OPERATION INCR. 1.00  
OPERATION COMPUT. 1.00  
RAIN DEPTH= 1.00  
STORM NO.= 1

MAIN TIME INCREMENT= 0.25  
FROM XSECTN/STRUCT 0/1  
RAIN DURATION= 1.00  
TO XSECTN/STRUCT 0/1  
SOIL CONDITION= 3

RAIN TABLE NO.= 3

SUBROUTINE RUNOFF STRUCTURE INPUT RUNOFF CURVE= 85.0  
AREA= 0.28 COMPUTED CURVE NO.= 92.8  
TIME OF CONCENTRATION= 0.35

PEAK TIMES  
1.11  
5.06  
10.03  
11.01  
15.87  
19.79  
22.60  
23.87

PEAK DISCHARGES  
16.489  
19.156  
143.158  
194.445  
1834.328  
44.030  
40.681  
43.196

PEAK ELEVATIONS  
(RUNOFF)  
(RUNOFF)  
(RUNOFF)  
(RUNOFF)  
(RUNOFF)  
(RUNOFF)  
(RUNOFF)  
(RUNOFF)

PMF

TIME  
1.25  
3.75  
6.25  
8.75  
11.25  
13.75  
16.25  
18.75  
21.25  
23.75

HYDROGRAPH, TZERO= 1.25  
1.22 3.40  
16.294 16.19  
105.78 118.03  
137.759 138.41  
141.95 143.63  
560.50/4 625.11  
759.32/9 872.51  
44.90/19 42.51  
40.69 40.69  
40.6824 20.55  
32.24  
31.2962

DELTA T= 0.25  
7.25 10.28  
17.55 18.61  
127.28 131.97  
141.23 142.04  
301.08 458.01  
588.58 1231.98  
521.53/20 516.49  
40.69 42.51  
40.65 40.69  
0.65 0.00

DRAINAGE AREA= 0.28  
12.193 12.67  
18.09 19.58  
133.618 134.95  
140.95 142.74  
465.35/3 511.58  
1673.71 1758.73  
514.45/8 278.76  
41.04 40.75  
40.6923 40.69

ACKE-FI= 4/9.07

CFS-HRS= 5797.09

TOTAL WATER, IN INCHES ON DRAINAGE AREA= 31.2962

SUBROUTINE RESVOR STRUCTURE 1  
SURFACE ELEVATION= 990.00

PEAK TIMES  
15.90

PEAK DISCHARGES  
1783.556

PEAK ELEVATIONS  
994.40

TIME  
1.25  
3.75  
6.25  
8.75  
11.25  
13.75  
16.25  
18.75

HYDROGRAPH, TZERO= 1.25  
0.04 0.21  
990.00 990.01  
5.74/4 6.53  
19.86 37.62  
129.249 131.91  
991.47 991.49  
142.26 142.42  
991.55 991.55  
553.31/4 589.19  
993.22/4 993.26  
267.23 719.00  
993.68 993.41  
175.15/9 135.48  
991.74 991.51

DELTA T= 0.25  
0.92 2.10  
990.03 990.06  
7.97 9.51  
73.56 99.33  
991.07 991.27  
135.82 139.20  
991.51 991.53  
167.22 307.08  
991.69 991.67  
640.89 647.08  
993.33 993.47  
671.85/17 627.70  
993.33/17 993.30  
100.33 69.82  
991.34 991.20

DRAINAGE AREA= 0.28  
2.79 3.52  
990.04 990.11  
10.18 10.83  
990.32 990.34  
108.14 115.02  
991.34 991.39  
139.89 140.48  
991.53 991.54  
361.86/3 412.04  
992.70 992.92  
1477.59 1727.23  
994.15 994.35  
520.12/8 442.25  
993.16 992.99  
61.90 56.37  
990.99 990.91

21.25	DISCHG	49.42	47.74	46.38	45.28	44.40	43.68	43.10	42.64	42.26	41.96
21.25	ELEV	990.89	990.87	990.96	990.65	990.04	990.03	950.83	990.82	990.82	990.02
23.75	DISCHG	41.71	41.52	39.41	34.16	28.00	22.67	18.72	17.31	16.00	14.74
23.75	FLEV	990.81	990.81	990.79	990.74	990.68	990.63	990.59	990.54	990.50	990.46

TOTAL WATER, IN INCHES ON DRAINAGE AREA= 31.0582      CFS-HRS= 5752.65      ACNE-FI= 475.39

ENUCMP 1



EXECUTIVE CONTROL CARD  
STARTING TIME = 0.00  
ALTERNATE NO. = 1  
OPERATION COMPUT. RAIN DEPTH = 1.00  
STORM NO. = 1  
FROM XSECTN/STRUCT RAIN DURATION = 1.00  
N/1  
10 XSECTN/STRUCT SOIL CONDITION = 3  
NO. = 4

SUBROUTINE RUNOFF STRUCTURE INPUT RUNOFF CURVE = 83.0 TIME OF CONCENTRATION = 0.35  
AREA = 0.28  
COMPUTED CURVE NO. = 92.8

100-Y ✓

PEAK DISCHARGES  
30.112  
407.074  
122.878  
18.350  
17.989  
18.007  
17.984  
17.980  
18.686

TIME	DISCHG	HYDROGRAPH, IZERO = 3.25	DELTA T = 0.25	UPLA T = 0.25	DRAINAGE AREA = 0.28
1.25	0.00	1.71	2.03	2.64	3.18
3.25	3.67	1.37	15.48	16.59	2.92
5.25	22.05	0.53	24.57	25.52	19.36
7.25	26.52	23.43	29.77	31.29	20.36
9.25	106.44	30.09	132.76	145.24	25.94
11.25	308.80	134.59	130.18	150.11	65.50
13.25	66.39	273.02	169.15	150.00	152.61
15.25	106.44	24.23	16.46	16.54	116.60
17.25	16.53	18.00	16.53	17.97	115.04
19.25	16.48	15.03	9.20	16.47	116.03
21.25				16.54	115.04
23.25				16.54	115.04

TOTAL WATER, IN INCHES ON DRAINAGE AREA = 6.8347 CFS-HRS = 1265.93 ACRE-FT = 104.61

SUBROUTINE RESVOR STRUCTURE INPUT SURFACE ELEVATION = 990.00

PEAK ELEVATIONS  
992.50

TIME	DISCHG	HYDROGRAPH, IZERO = 3.25	DELTA T = 0.25	UPLA T = 0.25	DRAINAGE AREA = 0.28
1.25	0.00	0.03	0.35	0.49	0.97
3.25	990.00	0.12	990.01	990.01	0.80
5.25	1.33	1.87	3.45	4.41	990.02
7.25	990.04	990.05	990.10	990.13	6.42
9.25	9.45	11.38	13.22	14.10	990.20
11.25	990.29	990.35	990.41	990.44	15.76
13.25	18.07	20.87	23.66	24.98	990.49
15.25	990.57	990.61	990.64	990.69	37.50
17.25	70.17	89.98	104.69	113.72	990.77
19.25	991.05	991.20	991.31	991.30	131.97
21.25	266.41	310.65	284.15	207.57	991.49
23.25	992.22	992.44	992.09	991.92	156.90
25.25	126.12	103.56	52.52	44.75	991.69
27.25	991.45	991.30	990.91	990.84	34.93
29.25	26.02	24.33	20.45	13.83	990.75
31.25	990.66	990.65	990.61	990.60	10.85
33.25	18.42	19.22	17.65	16.73	990.57
35.25	990.50	990.57	990.55	990.49	14.38
37.25	11.36	10.50	8.29	7.67	990.45
39.25	990.35	990.30	990.26	990.24	6.53

TOTAL WATER, IN INCHES ON DRAINAGE AREA = 6.7361 CFS-HRS = 1241.67 ACRE-FT = 103.10

ENDCHP 1

END OF JOB TR20 GGU

HATCH JOB